

**UT to Fourth Creek Stream Mitigation Site
Water Sampling and Benthic Macroinvertebrate Survey
TIP I-3819A**

Iredell County, North Carolina

Year 5 Monitoring Report



UT to Fourth Creek, Site 2 during 2019 survey



**The North Carolina Department of Transportation
Environmental Analysis Unit**

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TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
2.0	SITE DESCRIPTIONS	1
3.0	METHODOLOGY	2
3.1	BMI Sampling.....	2
3.1.1	Field Methods	2
3.1.2	Water Chemistry	2
3.1.3	Sample Processing	2
3.1.4	Data Analysis	3
4.0	RESULTS	3
4.1	BMI Community Analysis	3
4.2	Physicochemical Analysis.....	4
4.3	Habitat Assessment Scores.....	4
5.0	DISCUSSION/CONCLUSIONS.....	5
6.0	LITERATURE CITED	7

Table 1.	BMI Analysis Metrics.....	3
Table 2.	Physicochemical Data.....	4
Table 3.	Habitat Assessment Scores	5

Appendix A. Survey Site Location Map

Appendix B. Benthic Macroinvertebrate Survey Results

Table 4.	Baseline MY-00 (2014) and MY-01 (2015) Taxa list with indications of relative abundance for Sites 1-3.....	11
Table 5.	2016 MY-02 Taxa list.....	13
Table 6.	Taxa richness and summary parameters, UT to Fourth Creek, Iredell County, North Carolina, May 2014, June 2015, and June 2016.....	17
Table 7.	Taxa list with indications of relative abundance for Sites 1-3, UT to Fourth Creek, Iredell County, North Carolina, MY-03 (2017)	17
Table 8.	Taxa list with indications of relative abundance for Sites 1-3, UT to Fourth Creek, Iredell County, North Carolina, MY-04 (2018)	19
Table 9.	Taxa list with indications of relative abundance for Sites 1-3, UT to Fourth Creek, Iredell County, North Carolina, MY-05 (2019).	22

Appendix C. Site Photos (Sites 1-3)

Appendix D. Habitat Assessment Field Data Sheets and Benthos Collection Cards

1.0 INTRODUCTION

The North Carolina Department of Transportation (NCDOT) is evaluating the benthic macroinvertebrate (BMI) community for the Unnamed Tributary (UT) to Fourth Creek Stream Mitigation Site, related to impacts associated with TIP I-3819A, in Iredell County, North Carolina. The project includes three sites in UT to Fourth Creek (Figure 1). Three Oaks Engineering (Three Oaks) conducted the Monitoring Year (MY)-05 water sampling and benthic macroinvertebrate surveys on June 14, 2019. UT to Fourth Creek is a tributary to the South Yadkin River and is located within U.S. Geological Survey (USGS) Hydrologic Unit (HU) 03040102 and NC Division of Water Resources (NCDWR) sub-basin 03-07-06 of the Yadkin-Pee Dee River Basin.

2.0 SITE DESCRIPTIONS

Collections of benthic macroinvertebrates were made from three sampling locations: Site 1, Site 2, and Site 3 (Appendix A, Figure 1). The stream conditions for MY-05 at each site were very similar to the 2014 MY-00 baseline, 2015 MY-01, 2016 MY-02, 2017 MY-03, and 2018 MY-04 conditions. See Appendix C for MY-05 site photos.

Site 1. Site 1 was the most upstream site located on UT to Fourth Creek. Stream conditions were very similar to the 2018 surveys. At the time of the surveys top of bank width was approximately 3 meters (m) while wetted width was 2 m. The bank height was approximately 3 m from the deepest part of the channel to the top of bank with moderate bank erosion evident on the left descending bank. Water depth ranged from 0.25 to 0.5 m. Flow conditions were moderate, and the channel was wetted in most of the reach, with substrate exposed at the edges of meanders and in bars. The habitat consisted of a riffle/pool/run sequence. Substrate was composed of cobble, gravel, sand, and silt. No aquatic vegetation was present (Appendix C, Photos 1 and 2). The riparian canopy on the left descending bank was narrow with mature trees, shrubs, and grasses, while the right descending side was relatively wide. The surrounding buffer was dominated by shrubs and grasses with few mature trees.

Site 2. Site 2 was located approximately 200 m downstream of Site 1. The stream was moderately channelized and very narrow. The top of bank width was estimated to be 1 m and stream wetted width was approximately 1 m. The bank height from the deepest part of the channel to the top of bank was approximately 1.5 m, while water depth ranged from 0.25 to 1 m. Flow conditions were normal; the channel was wetted with little to no substrate exposed. In-stream habitat consisted of a riffle/pool/run sequence with a run dominating the survey reach. The substrate was composed mainly of sand with some gravel and silt. There was very little aquatic vegetation (Appendix C, Photos 3 and 4). In contrast to Site 1 and Site 3, the riparian buffer was composed mostly of grasses and shrubs with only partial canopy shading by black willow saplings and herbaceous vegetation.

Site 3. Site 3 was the most downstream sampling site, approximately 600 m downstream of Site 2 and just downstream of Interstate 40. The top of bank width was approximately 4 m and stream wetted width ranged from 2 to 3 m. Bank height from the deepest part of the channel to

the top of bank was approximately 3 m and stream depth ranged from 0.25 to 0.5 m. The stream banks exhibited moderate signs of erosion, with the right descending bank exhibiting severe erosion in portions of the survey reach. Flow conditions were normal; the channel was wetted with little to no substrate exposed. Substrate was made up primarily of cobble, gravel, and sand with some silt present. Instream habitat consisted of a riffle/pool/run sequence (Appendix C, Photos 5 and 6). The riparian buffer was more mature and much wider than at the other two sites providing shade throughout.

3.0 METHODOLOGY

3.1 BMI Sampling

The BMI and water quality MY-05 surveys were conducted by Lizzy Stokes-Cawley, Evan Morgan, and Paige Green for all sites on June 14, 2019.

3.1.1 Field Methods

Water quality monitoring programs have been implemented by North Carolina Department of Environmental Quality (NCDEQ, formerly the NC Department of Environment and Natural Resources, NCDENR) Division of Water Resources (NCDWR) to assess water quality trends in North Carolina. One method used is the monitoring of BMI, or benthos, to assess water quality by sampling for selected organisms. The species richness and overall biomass, as well as the presence of various benthic groups intolerant of water quality degradation, are reflections of water quality.

Sites were sampled one time utilizing methodology described in the NCDWR's *Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates, Version 5.0* (NCDEQ 2016). All sites were sampled utilizing the NCDWR Qual 4 collection method with the addition of a log wash with a fine mesh sampler. Qualitative collections of aquatic macroinvertebrates were made with D-frame aquatic dip nets, kick nets, a #30 sieve sand sample, and hand picking organisms from substrates. A multiple habitat approach was used, where specimens from all available habitats (stream margins, leaf packs, aquatic vegetation, detritus, woody debris and logs, and sand accumulations) were combined to form one aggregate sample. Samples were preserved in the field with 90% ethyl alcohol and delivered to Eaton Scientific on June 14, 2019. Habitat scores were determined using the Habitat Assessment Field Data Sheet for Mountain/Piedmont Streams (Appendix D). Benthos Collection Cards are also included (Appendix D).

3.1.2 Water Chemistry

Water chemistry was measured at each site in conjunction with BMI sampling. Parameters measured were temperature, dissolved oxygen (DO), specific conductivity, and pH (Table 2).

3.1.3 Sample Processing

BMI were sorted from debris, counted, and identified to the lowest taxonomic level with microscopic techniques and taxonomic keys (Appendix B). Eaton Scientific maintains the collected

specimens. Please note that a different lab (Pennington and Associates) was used to determine benthic species for MY-02, therefore, those results are presented in a different format.

3.1.4 Data Analysis

Analysis of, and comparison between, the BMI communities at each site were determined with established indices and metrics described in the *Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates, Version 5.0* (NCDEQ 2016). The metrics used in this evaluation included total taxa richness; Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness; and NC Biotic Index (BI) assigned value (Table 1). Other information used in the analysis included Habitat Assessment Field Data Sheet scores, observations, and best professional judgment (Table 3). The primary output was a taxa list, which included total number of organisms, total number for each taxon, EPT index, and assigned BI values.

Several data-analysis summaries (metrics) can be produced from such samples to evaluate biological conditions. These metrics are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted or otherwise stressed streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a BI.

Total taxa, EPT taxa richness, and BI values were compared between sites and monitoring year. In general, higher EPT taxa richness values and lower BI values usually indicate better stream quality. BI ratings range from 1-10 with a score of 1 generally reflecting high stream quality based on benthic macroinvertebrate diversity and habitat availability, while a higher score generally reflects lower stream quality.

4.0 RESULTS

4.1 BMI Community Analysis

The taxa list, analysis metrics, and additional laboratory data are presented in Appendix B. Table 1 compiles the analysis metrics created from data collected from 2014 through 2019.

Table 1. BMI Analysis Metrics

Date	Site	Total Taxa Richness	EPT Taxa Richness	Biotic Index
Baseline MY-00 (2014)	1	31	11	4.7
	2	32	7	5.8
	3	40	10	6.1
MY-01 (2015)	1	17	8	4.5
	2	38	8	5.6
	3	26	7	5.6
MY-02 (2016)	1	39	12	5.5
	2	52	12	5.7
	3	55	11	6.1
MY-03 (2017)	1	23	6	4.9
	2	18	2	5.1
	3	27	7	5.7

Date	Site	Total Taxa Richness	EPT Taxa Richness	Biotic Index
MY-04 (2018)	1	18	6	5.0
	2	26	4	5.7
	3	35	7	5.6
MY-05 (2019)	1	38	9	5.6
	2	40	8	6.2
	3	24	6	5.9

4.2 Physicochemical Analysis

Measured water chemistry data are listed in Table 2.

Table 2. Physicochemical Data

Sampling Date	Site	Water Temp (°C)	pH	Dissolved Oxygen (DO) (mg/L)	Specific Conductivity (uS/cm)
Baseline MY-00 (2014)	1	18.6	8*	9.6	197.3
	2	18.9	7.18*	9.08	202.0
	3	20.7	7.43	8.4	110.0
MY-01 (2015)	1	20.3	7.85	8.13	193.2
	2	19.9	7.1	8.8	193.4
	3	24.5	7.3	7.02	106.2
MY-02 (2016)	1	22.0	6.95	8.07	193.2
	2	21.9	6.90	8.4	189.3
	3	24.4	7.85	8.28	129.7
MY-03 (2017)	1	18.6	8.1	8.2	200.8
	2	19.3	6.75	9.5	192.5
	3	25.5	7	7.5	102.7
MY-04 (2018)	1	17.3	7.06	11.48	188.3
	2	17.4	6.69	10.35	190.3
	3	23.1	7.55	9.6	98.0
MY-05 (2019)	1	15.7	6.76	8.21	227.0
	2	15.5	6.88	8.15	217.3
	3	20.6	7.2	8.29	109.2

*Re-measured on 5/23/14 due to pH probe malfunction

4.3 Habitat Assessment Scores

Habitat scores were determined using the Habitat Assessment Field Data Sheet for Mountain/Piedmont Streams and are shown in Table 3. These visual-based habitat evaluation scores consist of eight parameters that rate channel modification, instream habitat, bottom substrate, pool variety, riffle habitat, bank stability and vegetation, light penetration, and riparian vegetation zone width for each sampling reach. A numerical score is used to rate each parameter and the total score gives a relative measure of overall habitat quality (Appendix D).

Table 3. Habitat Assessment Scores

Sample Year	Site	Channel Modification	Instream Habitat	Bottom Substrate	Pool Variety	Riffle Habitats	Bank Stability and Vegetation	Light Penetration	Riparian Vegetation Zone Width	Total
Baseline MY-00 (2014)	1	5	16	12	6	14	11	8	5	77
	2	3	10	3	4	3	4	2	0	29
	3	4	16	11	8	7	12	10	10	78
MY-01 (2015)	1	5	16	11	10	16	13	10	5	86
	2	4	10	3	6	7	8	7	10	55
	3	4	16	11	10	14	13	10	5	88
MY-02 (2016)	1	5	16	11	10	16	13	10	10	86
	2	4	10	3	6	7	11	7	10	58
	3	4	16	11	10	14	13	10	5	86
MY-03 (2017)	1	4	16	11	10	16	13	10	10	90
	2	4	10	3	6	7	11	7	10	58
	3	4	16	14	10	14	13	10	10	91
MY-04 (2018)	1	4	16	12	10	14	13	20	10	89
	2	4	10	3	6	7	11	7	9	57
	3	4	16	12	10	16	13	10	10	91
MY-05 (2019)	1	4	16	14	10	14	10	10	10	88
	2	4	11	3	6	7	12	7	9	59
	3	4	16	15	10	14	13	10	10	92
Highest Possible Score	Total	15	20	15	10	16	20	10	10	100

5.0 DISCUSSION/CONCLUSIONS

The benthic macroinvertebrate fauna was analyzed to produce BI values; physiochemical properties and habitat were measured to assess site quality. The 2019 MY-05 BI values range from 5.6 to 6.2 (mean 5.9), and when compared to previous monitoring data, there is little change in BI values indicating little change in stream quality.

Water quality parameters measured included temperature, pH, DO, and specific conductivity. Overall the water chemistry results are similar to previous monitoring years. According to the NCDEQ and U.S. Environmental Protection Agency (EPA) Water Quality Standards Table, all sites have pH and DO levels within the appropriate range for freshwater aquatic life. The pH range for freshwater aquatic wildlife is between 6 and 9 (NCDENR 2013) and Sites 1-3 ranged from 6.76 - 7.2 in 2019. The DO levels for all sites were above the minimum standard of 5.0 mg/L ranging from 8.15 to 8.29 mg/L (NCDENR 2013). DO has consistently been above the minimum standard in all monitoring years. Specific conductivity readings within rivers in the United States generally range from 50 to 1500 $\mu\text{S}/\text{cm}$ (EPA 2012). Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a specific conductivity range between 150 and 500 $\mu\text{S}/\text{cm}$ (EPA 2012). Sites 1-3 had results between 109.2 to 227.0 $\mu\text{S}/\text{cm}$. All sites specific conductivity ratings fell in range for streams in the United States; Site 1 and Site 2 had specific conductivity readings of 227.0 $\mu\text{S}/\text{cm}$ and 217.3 $\mu\text{S}/\text{cm}$, respectively, values which fall into the range for streams supporting good mixed fisheries.

Sites 1, 2, and 3 all had numbers of total taxa between 24 and 38 and EPT Taxa Richness between 6 and 9. Habitat assessment scores in 2019 were similar to scores in 2018. Prior to 2019,

there had been overall improvement in habitat assessment scores with the biggest improvement seen from the baseline surveys in 2014 to MY-01 surveys in 2015. In fall 2018, the region was hit by damaging flooding associated with Hurricanes Florence and Michael. During sampling in 2019, both Site 2 and Site 3 exhibited moderate to patchy severe bank erosion. Site 3 exhibited changes in stream substrate including higher percentages of sand and silt.

This data provides baseline and post construction conditions for aquatic community parameters in the project area that can be used to monitor changes in water quality over time.

6.0 LITERATURE CITED

NC Department of Environment and Natural Resources (NCDENR). 2013. North Carolina Surface Waters and Wetland Standards (NC Administrative Code 15A NCAC 02B. .0100 & .0200) Amended Effective April 1, 2003.

NC Department of Environmental Quality (NCDEQ). 2016. Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates, Version 5.0. Division of Water Resources. Raleigh, North Carolina. February 2016.

U.S. Environmental Protection Agency (EPA). 2012. Water: Monitoring & Assessment. 5.9 Conductivity. What is conductivity and why is it important?
<http://water.epa.gov/type/rsl/monitoring/vms59.cfm>

Appendix A.

BMI Survey Site Location Map



UT to Fourth Creek Stream Mitigation Site (STIPI-3819A)

Water Sampling and Benthic
Macroinvertebrate Survey

Iredell County, North Carolina

Date:	June 2019
Scale:	0 50 100 Meters
Job No.:	19-313
Drawn By:	LSC
Checked By:	TED

Figure

1

Appendix B.
Benthic Macroinvertebrate Survey Results

Table 4. Baseline MY-00 (2014) and MY-01 (2015) Taxa list with indications of relative abundance for Sites 1-3.
[A=Abundant (>10), C=Common (3-9), and R=Rare (1-2)]

	Site:	2014			2015		
		1	2	3	1	2	3
EPHEMEROPTERA							
<i>Maccaffertium modestum</i>		A	A	C	A	A	A
<i>Baetis flavistriga</i>		R	-	R	-	-	-
<i>Baetis intercalaris</i>		R	-	C	-	-	R
<i>Baetis pluto</i>		A	A	C	A	C	-
<i>Labiobaetis frondale</i>		C	R	-	-	R	-
<i>Labiobaetis propinquum</i>		-	R	C	-	R	-
<i>Callibaetis</i> sp		-	-	-	R	-	-
<i>Eurylophella verisimilis</i>		R	C	-	-	-	-
PLECOPTERA							
<i>Eccoptura xanthenes</i>		-	-	R	-	-	-
<i>Amphinemura</i> sp		-	-	C	-	-	-
TRICHOPTERA							
<i>Cheumatopsyche</i> spp		R	-	A	C	A	C
<i>Hydropsyche betteni</i>		C	-	A	C	C	A
<i>Diplectrona modesta</i>		C	-	-	C	C	-
<i>Chimarra</i> sp		-	-	-	A	A	C
<i>Oecetis persimilis</i>		-	-	R	-	-	-
<i>Neophylax atlanta</i>		A	-	-	A	-	-
<i>Pycnopsyche</i> sp		R	R	-	-	-	R
<i>Ironoquia punctatissima</i>		-	R	-	-	-	-
<i>Lype diversa</i>		-	-	-	-	-	R
COLEOPTERA							
<i>Macronychus glabratus</i>		-	-	C	-	-	C
<i>Stenelmis</i> sp		-	-	R	-	C	C
<i>Helichus</i> spp		R	C	-	-	R	-
<i>Anchytarsus bicolor</i>		-	-	R	-	-	C
<i>Neoporus</i> spp		R	C	-	-	C	-
<i>Dineutus</i> sp		-	-	C	-	-	R
<i>Cymbiodyta</i> sp		-	-	-	-	R	-
ODONATA							
<i>Calopteryx</i> sp		A	C	C	-	A	R
<i>Gomphus</i> sp		-	-	R	-	-	-
<i>Lanthus</i> sp		-	-	-	-	R	-
<i>Baesiaeschna janata</i>		-	-	C	-	-	-
<i>Boyeria vinosa</i>		-	-	R	-	C	C
<i>Cordulegaster</i> sp		-	-	-	-	R	-
MEGALOPTERA							
<i>Nigronia serricornis</i>		-	-	R	R	-	C
<i>Corydalus cornutus</i>		-	-	R	-	-	R
DIPTERA: MISC.							
<i>Dicranota</i> sp		C	R	R	R	R	-

<i>Anthocha</i> sp	-	-	-	<i>R</i>	-	-
<i>Hexatoma</i> sp	-	-	<i>R</i>	-	-	-
<i>Pseudolimnophila</i> sp	<i>R</i>	<i>C</i>	-	-	<i>R</i>	-
	2014			2015		
Site:	1	2	3	1	2	3
<i>Simulium</i> spp	<i>A</i>	<i>A</i>	<i>A</i>	<i>R</i>	<i>C</i>	<i>A</i>
<i>Dixa</i> spp	<i>A</i>	<i>R</i>	<i>C</i>	-	<i>C</i>	<i>R</i>
<i>Muscidae</i> (<i>Limnophora</i> ?)	-	<i>C</i>	-	-	-	-
Empididae	-	-	-	-	<i>R</i>	-
DIPTERA: CHIRONOMIDAE						
<i>Conchapelopia</i> group	<i>C</i>	<i>C</i>	<i>C</i>	<i>C</i>	<i>A</i>	<i>R</i>
<i>Zavrelimyia</i> sp	-	<i>R</i>	-	<i>R</i>	-	-
<i>Brillia</i> sp	<i>R</i>	-	-	-	-	-
<i>Cricotopus annulator</i> Gr	<i>C</i>	<i>C</i>	-	-	-	-
<i>Orthocladius obumbratus</i>	<i>R</i>	<i>A</i>	-	-	-	-
<i>Paraphaenocladius</i> sp	-	<i>R</i>	-	-	-	-
<i>Parametriocnemus lundbecki</i>	<i>C</i>	-	-	<i>R</i>	<i>A</i>	<i>C</i>
<i>Tvetenia bavarica</i> gr	-	-	<i>R</i>	-	<i>R</i>	-
<i>Eukiefferiella claripennis</i> gr	<i>R</i>	<i>R</i>	-	-	-	-
<i>Odontomesa fulva</i>	<i>C</i>	<i>C</i>	-	-	-	-
<i>Chironomus</i> sp	<i>C</i>	<i>C</i>	<i>R</i>	<i>R</i>	<i>C</i>	-
<i>Cryptochironomus</i> spp	-	<i>R</i>	<i>R</i>	-	<i>C</i>	-
<i>Microtendipes</i> sp	-	-	-	-	<i>R</i>	-
<i>Paratendipes</i> sp	<i>R</i>	<i>C</i>	-	-	<i>R</i>	-
<i>Phaenopsectra obediens</i> gr	-	<i>C</i>	<i>R</i>	-	<i>R</i>	-
<i>Phaenopsectra</i> sp	-	-	-	-	<i>R</i>	-
<i>Polypedilum flavum</i>	<i>C</i>	<i>R</i>	<i>C</i>	-	<i>A</i>	<i>C</i>
<i>Polypedilum tritum</i>	<i>R</i>	-	<i>R</i>	-	-	-
<i>Polypedilum fallax</i>	-	<i>R</i>	-	-	-	-
<i>Polypedilum illinoense</i>	-	-	-	-	<i>R</i>	-
<i>Stenochironomus</i> sp	-	-	-	-	-	<i>R</i>
<i>Stictochironomus</i> sp	<i>C</i>	-	-	-	<i>C</i>	-
<i>Tribelos jucundum</i>	-	-	<i>R</i>	-	-	-
<i>Micropsectra</i> sp	<i>C</i>	<i>C</i>	-	-	<i>C</i>	-
<i>Paratanytarsus</i> sp	-	-	<i>R</i>	-	-	-
<i>Rheotanytarsus</i> spp	-	-	<i>R</i>	-	-	<i>R</i>
OLIGOCHAETA						
<i>Stylaria lacustris</i>	-	-	<i>R</i>	-	-	-
<i>Ecclipidrilus</i> spp	-	-	<i>R</i>	-	-	-
CRUSTACEA						
<i>Caecidotea</i> sp (small)	-	<i>C</i>	<i>R</i>	-	<i>R</i>	<i>R</i>
<i>Cambarus</i> spp	-	-	<i>A</i>	<i>R</i>	-	<i>A</i>
MOLLUSCA						
<i>Corbicula fluminea</i>	-	-	<i>A</i>	-	-	<i>A</i>
-						
OTHER						
Hirudinea						
<i>Placobdella parasitica</i>	-	-	<i>R</i>	-	-	-
Hemiptera						
Corixidae	-	-	-	-	<i>R</i>	-

Table 5. 2016 MY-02 Taxa list.

STATION			SITE 1	SITE 2	SITE 3
SPECIES	T.V.	F.F.G.			
MOLLUSCA					
Bivalvia					
Veneroida					
Corbiculidae					
<i>Corbicula fluminea</i>	6.6	FC			6
Gastropoda					
Mesogastropoda					
Pleuroceridae	2.7				
<i>Elimia proxima</i>	2.7	SC			9
Basommatophora					
Ancylidae		SC			
<i>Ferrissia rivularis</i>	6.6	SC			1
ANNELIDA					
Clitellata					
Oligochaeta		CG			
Tubificida					
Naididae					
Naidinae		CG			1
<i>Nais behningi</i>	8.7	CG			2
<i>Nais communis</i>	8.7	CG		1	2
<i>Nais sp.</i>	8.7	CG			1
Tubificinae w.h.c.		CG			2
Tubificinae w.o.h.c.		CG	1		9
Pristininae					
<i>Pristina sp.</i>	7.7	CG		1	2
ARTHROPODA					
Arachnoidea					
Acariformes				3	2
Sperchontidae					
<i>Sperchon sp.</i>					1
Crustacea					
Isopoda					
Asellidae		SH			
<i>Caecidotea sp.</i>	8.4	CG	3	1	
Decapoda					
Cambaridae			16		
<i>Cambarus sp.</i>	7.5	CG	2	11	3
STATION			SITE 1	SITE 2	SITE 3

SPECIES	T.V.	F.F.G.			
Insecta					
Collembola					
Isotomidae			3	8	
Ephemeroptera					
Baetidae		CG	3		2
<i>Acentrella sp.</i>	2.5	CG	1		
<i>Baetis sp.</i>		CG		2	
<i>Baetis intercalaris</i>	5	CG		2	5
<i>Baetis pluto</i>	3.4			2	
<i>Labiobaetis sp.</i>		CG		1	1
Ephemerellidae		SC	1		
Heptageniidae		SC	4		13
<i>Maccaffertium sp.</i>		SC	59	34	30
Leptophlebiidae		CG		3	
Odonata					
Aeshnidae		P			1
Calopterygidae		P			
<i>Hetaerina sp.</i>	4.9	P	8	25	20
Coenagrionidae		P			
<i>Argia sp.</i>	8.3	P			2
Cordulegastridae		P			
<i>Cordulegaster sp.</i>	5.7	P	1	1	
Gomphidae		P		1	1
<i>Progomphus obscurus</i>	8.2	P		1	2
<i>Stylogomphus albistylus</i>	5	P	2	4	
Hemiptera					
Veliidae		P	1	2	
<i>Rhagovelia obesa</i>		P	3		
Trichoptera					
Hydropsychidae		FC	22		13
<i>Cheumatopsyche sp.</i>	6.6	FC			17
<i>Diplectrona modesta</i>	2.3	FC	8	8	
<i>Hydropsyche depravata gp.</i>	7.9	FC		1	14
<i>Hydropsyche sp.</i>		FC	2	1	19
Lepidostomatidae		SH			
<i>Lepidostoma sp.</i>	1	FC	11	3	
Leptoceridae		CG			1
Philopotamidae		FC			
<i>Chimarra aterrima</i>	3.3	FC	27	7	7
<i>Dolophilodes distinctus</i>	1	FC	1		
Psychomyiidae		CG			
STATION			SITE 1	SITE 2	SITE 3

SPECIES	T.V.	F.F.G.			
<i>Lype diversa</i>	3.9	SC	2		
Rhyacophilidae		P			
<i>Rhyacophila carolina</i>	0.4	P		1	
Coleoptera					
Dryopidae					
<i>Helichus sp.</i>	4.1	SC		1	
Elmidae		CG			
<i>Macronychus glabratus</i>	4.7	SH			5
<i>Optioservus sp.</i>	2.1	SC			1
<i>Stenelmis sp.</i>	5.6	SC	5	4	6
Ptilodactylidae		SH			
<i>Anchytarsus bicolor</i>	2.4	SH			3
Diptera					
Ceratopogonidae		P			
<i>Atrichopogon sp.</i>	6.1	P	2		
Chironomidae					
<i>Ablabesmyia mallochii</i>	7.4	P			7
<i>Conchapelopia sp.</i>	8.4	P	30	35	18
<i>Corynoneura sp.</i>	5.7	CG	3	2	5
<i>Cryptochironomus sp.</i>	6.4	P			1
<i>Eukiefferiella sp.</i>		CG	2		
<i>Eukiefferiella claripennis gp.</i>	6.2	CG	2	1	
<i>Nilotanytus fimbriatus</i>	4.1				2
<i>Odontomesa fulva</i>	4.9			1	
<i>Paracladopelma sp.</i>	6.3	CG			1
<i>Parametriocnemus sp.</i>	3.9	CG	10	15	14
<i>Paratanytarsus dissimilis</i>	8				1
<i>Paratendipes albimanus/duplicatus</i>	5.6			2	
<i>Phaenopsectra obediens gp.</i>	6.6	SC	40	2	1
<i>Phaenopsectra punctipes gp.</i>	7.1	SC	2		
<i>Polypedilum fallax gp.</i>	6.5	SH		1	
<i>Polypedilum flavum</i>	5.7	SH	3	15	20
<i>Polypedilum illinoense gp.</i>	8.7	SH	10	4	
<i>Pseudosmittia sp.</i>		CG		1	
<i>Rheotanytarsus exiguus gp.</i>	6.5	FC	13	16	14
<i>Rheotanytarsus pellucidus</i>	6.5	FC		2	
<i>Rheocricotopus robacki</i>	7.9	CG			4
<i>Stenochironomus sp.</i>	6.3	SH			6
<i>Tanytarsus sp.</i>	6.6	FC	3	5	1
<i>Thienemanniella xena</i>	8	CG			1
<i>Tribelos jucundum</i>	5.7				1
STATION			SITE 1	SITE 2	SITE 3

SPECIES	T.V.	F.F.G.			
<i>Zavrelimyia sp.</i>	8.6	P	2	1	2
Dixidae		CG			
<i>Dixa sp.</i>	2.5	CG	1	2	1
Dolichopodidae		P		2	
Empididae		P		1	
<i>Hemerodromia sp.</i>		P		1	5
Psychodidae		CG			
<i>Pericoma sp.</i>		CG		2	
Sciaridae				1	
Simuliidae		FC			
<i>Simulium tuberosum</i>	4.9	FC		9	4
Tabanidae		PI			
<i>Tabanus sp.</i>	8.5	PI			1
Tipulidae		SH		1	
<i>Dicranota sp.</i>	0	P	1	6	
<i>Limnophila sp.</i>		P			1
<i>Pseudolimnophila sp.</i>	6.2	P	17	15	
<i>Tipula sp.</i>	7.5	SH		1	
TOTAL NO. OF ORGANISMS			327	273	315
TOTAL NO. OF TAXA			39	52	55
EPT INDEX			12	12	11
NCBI Assigned values			5.48	5.67	6.09

Table 6. Taxa richness and summary parameters, UT to Fourth Creek, Iredell County, North Carolina, May 2014, June 2015, and June 2016.

	2014			2015			2016		
	1	2	3	1	2	3	1	2	3
Ephemeroptera	6	5	5	3	4	2	66	42	49
Plecoptera	-	-	2	-	-	-	-	-	-
Trichoptera	5	2	3	5	4	5	73	21	71
Coleoptera	2	2	4	-	4	4	5	5	15
Odonata	1	2	4	-	4	2	11	32	26
Megaloptera	-	-	2	1	-	2	-	-	-
Diptera; Misc.	4	6	5	4	6	3	2	-	-
Diptera: Chironomidae	13	14	10	4	13	5	120	103	99
Oligochaeta	-	-	2	-	-	-	1	2	19
Crustacea	-	1	2	-	2	2	21	12	3
Mollusca	-	-	1	-	-	1	-	-	6
Other	-	-	1	-	1	-	45	67	37
Total Taxa Richness	31	32	41	17	38	26	327	273	315
EPT Taxa Richness	11	7	10	8	8	7	39	52	55
NC Biotic Index	4.7	5.8	6.1	4.5	5.6	5.6	5.5	5.7	6.9
Bioclassification (Small stream*)	G	G-F	F	G	G-F	G-F	G-F	G-F	F

*Assumes permanent flow, unlikely for these streams. Sites 2 and 3 fall right on the dividing line between Good-Fair and Fair; they are not significantly different.
G=Good, G-F=Good-Fair, F=Fair

**Table 7. Taxa list with indications of relative abundance for Sites 1-3, UT to Fourth Creek, Iredell County, North Carolina, MY-03 (2017).
[A=Abundant (>10), C=Common (3-9), and R=Rare (1-2)]**

<u>Taxa / UT Fourth Cr</u>	<u>1</u>	<u>2</u>	<u>3</u>
EPHEMEROPTERA			
Family Baetidae			
<i>Baetis intercalaris</i> (5.0)	-	-	C
<i>Baetis pluto</i> (3.4)	C	-	-
<i>Pseudocloeon frondalis</i> (4.6)	-	R	R
Family Heptageniidae	-	-	-
<i>Maccaffertium modestum</i> (5.7)	A	R	A
PLECOPTERA			
Family Perlidae	-	-	R
TRICHOPTERA			
Family Hydropsychidae			
<i>Cheumatopsyche spp</i> (6.6)	C	-	A
<i>Diplectrona modesta</i> (2.3)	A	-	-
<i>Hydropsyche betteni</i> (7.9)	-	-	A

Family Limnephilidae			
<i>Neophylax atlanta</i>	A	-	-
Family Philopotamidae			
<i>Chimarra spp (3.3)</i>	A	-	A
MISC DIPTERA			
Family Culicidae			
<i>Anopheles sp (8.6)</i>	-	R	-
Family Dixidae			
<i>Dixa spp (2.5)</i>	C	C	-
<i>Dixella spp (4.9)</i>	R	C	-
Family Simuliidae			
<i>Simulium spp (4.9)</i>	C	-	A
Family Tipulidae			
<i>Antocha spp (4.4)</i>	R	-	-
<i>Dicranota spp (0)</i>	-	R	R
<i>Hexatoma spp (3.5)</i>			R
<i>Pseudolimnophila spp (6.2)</i>	R	R	R
<i>Tipula spp (7.5)</i>	R	R	C
DIPTERA; CHIRONOMIDAE			
<i>Brillia flavifrons (5.7)</i>	-	R	-
<i>Chironomus spp (9.3)</i>	-	-	R
<i>Corynoneura spp (5.7)</i>	R	-	R
<i>Nilotanytus spp (4.1)</i>	-	-	R
<i>Parametriocnemus lundbecki (3.7)</i>	C	-	R
<i>Paratendipes albimanus (5.6)</i>	-	R	-
<i>Polypedilum aviceps (3.6)</i>	C	R	A
<i>Polypedilum flavum (5.7)</i>			A
<i>Polypedilum illinoense (8.7)</i>	C	C	R
<i>Polypedilum tritum</i>	R	-	-
<i>Tanytus neopunctipenis</i>	-	-	R
<i>Thienemannimyia group (8.4)</i>	C	R	C
<i>Zavrelimyia spp (6.1)</i>	-	R	-
COLEOPTERA			
Family Dryopidae			
<i>Helichus spp (4.1)</i>	-	R	-
Family Dytiscidae			
<i>Agabus spp (8.9)</i>	-	R	-
<i>Neoporus spp (5.0)</i>	-	R	-
Family Elmidae			
<i>Stenelmis spp (5.6)</i>	R	-	R
Family Gyrinidae			
<i>Dineutus spp (5.0)</i>	-	-	R
ODONATA			

Family Aeshnidae			
<i>Boyeria vinosa</i> (5.6)	-	-	C
Family Calopterygidae			
<i>Calopteryx</i> spp (7.5)	R	C	R
Family Coenagrionidae			
<i>Argia</i> spp (8.3)	-	-	C
OLIGOCHAETA			
Family Naidae			
<i>Pristina</i> spp (7.7)	R	-	C
MEGALOPTERA			
Family Corydalidae			
<i>Nigronia serricornis</i> (4.6)	-	-	C
CRUSTACEA			
Family Asellidae			
<i>Caecidotea</i> spp (8.4)	C	-	C
OTHER TAXA			
Family Vellidae			
<i>Rhagovelia</i> spp	R	-	-
<u>Site</u>	<u>1</u>	<u>2</u>	<u>3</u>
Total Taxa Richness	23	18	27
EPT Taxa Richness	6	2	7
EPT Abundance	46	2	45
Taxa \leq 4.0 Biotic Index	6	2	5
Biotic Index	4.88	5.09	5.71

Table 8. Taxa list with indications of relative abundance for Sites 1-3, UT to Fourth Creek, Iredell County, North Carolina, MY-04 (2018).
[A=Abundant (>10), C=Common (3-9), and R=Rare (1-2)]

<u>Statesville I-3819-A</u>	<u>1</u>	<u>2</u>	<u>3</u>
<u>Taxa / Biotic Index Value</u>			
EPHEMEROPTERA			
Family Baetidae			
<i>Baetis pluto</i> (3.4)	R	-	-
Family Ephemerellidae			
<i>Euryloplella funeralis</i> (2.5)	R	-	-
Family Heptageniidae			
<i>Maccaffertium modestum</i> (5.7)	A	A	A
TRICHOPTERA			
Family Hydropsychidae			
<i>Ceratopsyche sparna</i> (2.5)			

<i>Cheumatopsyche</i> spp (6.6)	C	R	A
<i>Diplectrona modesta</i> (2.3)	A	C	R
<i>Hydropsyche betteni</i> (7.9)	-	-	C
Family Limnephilidae			
<i>Pycnopsyche</i> sp. (2.5)	-	-	R
Family Philopotamidae			
<i>Chimarra</i> spp (3.3)	A	R	C
Family Psychomyiidae			
<i>Lype Diversa</i> (3.9)	-	-	R
MISC DIPTERA			
Family Dixidae			
<i>Dixa</i> spp (2.5)	C	R	R
<i>Dixella</i> spp (4.9)	R	R	-
Dolichopodidae	-	R	-
Family Simuliidae			
<i>Simulium</i> spp (4.9)	R	R	A
Family Tipulidae			
<i>Antocha</i> spp (4.4)	-	-	R
<i>Dicranota</i> spp (0.0)	R	-	R
<i>Pseudolimnophila</i> spp (6.2)	R	-	-
<i>Tipula</i> spp (7.5)	-	-	R
Family Ptychopteridae			
<i>Bitticomorpha</i>	-	R	-
DIPTERA; CHIRONOMIDAE			
<i>Brillia flavifrons</i> (3.9)	-	R	R
<i>Corynoneura</i> spp (5.7)	-	R	-
<i>Parametriocnemus lundbecki</i> (3.7)	-	R	R
<i>Paratanytarsus</i> spp (8.0)	-	R	-
<i>Phaenopsctra obediens</i> gp (6.5)	R	R	-
<i>Polypedilum aviceps</i> (3.6)	-	R	-
<i>Polypedilum flavum</i> (5.7)	-	R	C
<i>Polypedilum illinoense</i> (8.7)	C	R	R
<i>Polypedilum tritum</i>	R	R	R
<i>Rheotanytarsus</i> spp (6.5)			R
<i>Stictochironomus devinctus</i> (5.4)	-	R	-
<i>Thienemaniella</i> spp (6.4)	-	-	R
<i>Thienemannimyia</i> group (8.4)	R	R	C
<i>Tribelos jacundum</i> (5.7)	-	-	R
<i>Tvetenia bavarica</i> gp (<i>E</i> sp 1) (3.6)	-	-	R
COLEOPTERA			
Family Dryopidae			
<i>Helichus</i> spp (4.1)	-	R	R
Family Elmidae			
<i>Macronychus glabratus</i> (4.7)	-	-	R
<i>Stenelmis</i> spp (5.6)	C	C	R

Family Gyrinidae			
<i>Dineutus spp</i> (5.0)	-	-	R
Family Ptilodactylidae			
<i>Anchytarsus bicolor</i> (2.4)	-	-	R
ODONATA			
Family Aeshnidae			
<i>Boyeria vinosa</i> (5.6)	-	R	R
Family Calopterygidae			
<i>Calopteryx spp</i> (7.5)	A	A	-
Family Coenagrionidae			
<i>Argia spp</i> (8.3)	-	-	R
Family Gomphidae			
<i>Gomphus spp</i> (5.9)	-	-	R
<i>Ophiogomphus spp</i> (5.9)	-	-	R
<i>Stylogomphus albistylus</i> (5.0)	-	C	-
OLIGOCHAETA			
Family Naidae			
<i>Nais spp</i> (8.7)	-	-	R
Family Tubificidae			
<i>Immature Tubificidae w/o hair setae</i> (7.1)	-	-	R
CRUSTACEA			
Family Asellidae			
<i>Caecidotea spp</i> (8.4)	R	-	-
Family Cambaridae			
<i>immature crayfish</i> (7.5)	-	-	R
OTHER TAXA			
Family Veliidae			
<i>Rhagovelia spp</i>	-	C	R
<u>Site</u>	<u>1</u>	<u>2</u>	<u>3</u>
Total Taxa Richness	18	26	35
EPT Taxa Richness	6	4	7
EPT Abundance	35	15	29
Biotic Index	4.98	5.71	5.63

Table 9. Taxa list with indications of relative abundance for Sites 1-3, UT to Fourth Creek, Iredell County, North Carolina, MY-05 (2019).
[A=Abundant (>10), C=Common (3-9), and R=Rare (1-2)]

Statesville restoration sites	1	2	3
Taxa / Biotic Index Value			
EPHEMEROPTERA			
Family Baetidae			
Baetis flavistriga (6.8)	R	R	
Baetis intercalaris (5.0)			R
Baetis pluto (3.4)	A	C	
Labiobaetis frondalis (4.6)	R	C	
Labiobaetis propinquus (5.8)		R	
Family Heptageniidae			
Maccaffertium modestum (5.7)	A	C	C
TRICHOPTERA			
Family Hydropsychidae			
Cheumatopsyche spp (6.6)	A	C	A
Diplectrona modesta (2.3)	C		R
Hydropsyche betteni (7.9)	A	C	C
Family Philopotamidae			
Chimarra spp (3.3)	A	R	C
Family Psychomyiidae			
Lype Diversa (3.9)	C		
MISC DIPTERA			
Family Ceratopogonidae			
Palpomyia complex (5.7)			
Family Dixidae			
Dixa spp (2.5)	R		
Dixella spp (4.9)		R	
Dolichopodidae		R	
Family Simuliidae			
Simulium spp (4.9)	C	C	A
Family Tipulidae			
Hexatoma spp (3.5)	R		
Polymeda/Ormosa spp (6.5)		R	
Pseudolimnophila spp (6.2)	C	C	
Tipula spp (7.5)	R	R	R
DIPTERA; CHIRONOMIDAE			
Ablabesmyia mallochi (7.4)	R		
Brillia flavifrons (5.7)	R		R
Chironomus spp (9.3)	R		
Corynoneura spp (5.7)	R		
Cryptochironomus fulvus (6.7)		R	R
Dicrotendipes neomodestus (7.9)		R	
Microtendipes pedellus (4.6)	R	R	

Parametrioctenus lundbecki (3.7)	R		
Paratanytarsus spp (8.0)	R		
Paratendipes albimanus (5.6)	R		
Phaenopsctra obediens gp (6.5)		C	
Phaenopsctra punctipes gr (7.1)	R	C	
Polypedilum aviceps (3.6)	C		
Polypedilum flavum (5.7)	R	R	R
Polypedilum halterale (7.4)			R
Polypedilum illinoense (8.7)	R	C	
Polypedilum tritum		C	
Rheotanytarsus spp (6.5)	R	R	R
Tanytarsus acifer		R	
Tanytarsus sp U (6.6)		R	
Tanytarsus sp Z (6.6)		R	
Thienemaniella spp (6.4)	R		
Thienemannimyia group (8.4)	C	A	C
Tribelos jacundum (5.7)	R	R	
COLEOPTERA			
Family Dryopidae			
Helichus spp (4.1)		C	
Family Dytiscidae			
Neoporus spp (7.0)		R	
Family Elmidae			
Macronychus glabratus (4.7)			R
Stenelmis spp (5.6)		R	
Family Hydrophilidae			
Enochrus spp (8.5)		R	
ODONATA			
Family Aeshnidae			
Aeshna umbrosa		R	
Boyeria vinosa (5.6)		R	R
Family Calopterygidae			
Calopteryx spp (7.5)	C	R	
Family Cordulegasteridae			
Cordulegaster spp (5.7)			R
Family Gomphidae			
Ophiogomphus spp (5.9)			R
Progomphus obscurus (8.2)			C
Stylogomphus albistylus (5.0)	R	R	
OLIGOCHAETA			
Family Naidae			
Pristinella spp (7.7)			R
Slavina appendiculata (8.4)	R		
MEGALOPTERA			
Family Corydalidae			

Nigronia serricornis (4.6)	R		
Family Sialidae			
Sialis spp (7.0)	R		
CRUSTACEA			
Family Asellidae			
Caecidotea spp (8.4)	C	R	
Family Cambaridae			
immature crayfish (7.5)	R	R	
MOLLUSCA			
Family Pleuroceridae			
Elimia spp (2.7)		R	C
Family Corbiculidae			
Corbicula fluminea (6.6)			C
OTHER TAXA			
Family Hydrachnidae			
Lebertia spp (5.5)			R
Family Veliidae			
Rhagovelia spp	C	C	R
Total Taxa Richness	38	40	24
EPT Taxa Richness	9	8	6
EPT Abundance	58	18	21
Biotic Index	5.61	6.18	5.89
Qual 4 Bioclassification	Good-Fair	Fair	Fair

Appendix C.
MY-04 Site Photos
(Sites 1-3)



Photo 1. Upstream facing view of Site 1.



Photo 2. Downstream facing view of Site 1



Photo 3. Downstream facing view of Site 2.



Photo 4. Upstream facing view of Site 2.



Photo 5. Downstream facing view of site 3.



Photo 6. Upstream facing view of Site 3.

Appendix D.
Habitat Assessment Field Data Sheet
for Mountain/Piedmont Streams and
Benthos Collection Cards
(Sites 1-3)